Influence of the Elasticity of Diffusant Vapors on the Electrical Properties of Selenium in Silicon

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It is known that the coefficients of diffusion and miscibility of selenium in silicon, determined by various authors, are rather different from each other. Such a discrepancy may be related to different doping conditions and, first of all, to different elasticity of diffusant vapors in the process of high-temperature diffusion.

From this point of view, investigation of the influence of the elasticity of selenium vapors on electrical properties of silicon is of a certain scientific and industrial interest. In order to study the influence of the elasticity of diffusant vapors on the diffusion coefficient, miscibility of selenium in silicon, as well as on electrical properties of silicon, we carried out high-temperature diffusion of selenium in silicon within a wide range of the elasticity of diffusant vapors (0.01-1.0 atm) at constant annealing temperature 1250 ºC. Variation of the elasticity of the diffusant vapors was carried out by changing the mass of selenium (inlet in an ampoule), and was determined by the state equation of gases. In order to get reliable information on the state of selenium atoms in silicon, it is necessary to know the concentration of electroactive atoms, coefficients of diffusion and miscibility. Analysis of the depth (Nse) allocation profile of selenium concentration in silicon showed that it may be described by erfc-function with the surface concentration Nse ~10^{16} cm^{-3} and the diffusion coefficient ~10^{-10} cm^2/s.

After the doping of silicon crystals by selenium, a depth of allocation of p-n-transition was determined, and the diffusion coefficient of selenium, depending on the diffusant pressure, was estimated. Concentration of selenium at the depth of p-n-transition may be determined on the basis of the electro-neutrality equation, taking into account the degree of filling of donor levels of selenium (it is well known that selenium provides silicon with two donor levels Ec –0.26 eV and Ev 0.51 eV). It should be noted that the concentration of electroactive atoms can be affected by the elasticity of diffusant vapors. That allows one to develop new technologies for obtaining compensated silicon doped by selenium.